REMARKS/ARGUMENTS

The Examiner is thanked for the Official Action dated April 20, 2005. This request for reconsideration is intended to be fully responsive thereto.

Claims 1-4 were rejected under 35 U.S.C. 103(a) as being unpatentable over JP 05-296009 (Yamanishi et al) in view of Wilkinson et al (USPN 4,333,515). This rejection is respectfully traversed in view of the following comments.

Regarding claim 1: The examiner alleges that Yamanishi teaches the exhaust gas recovery system comprising a steam turbine and a heat pump. Contrary to the Examiner's allegations, the system of Yamanishi lacks the heat pump. One of ordinary skill in the art would readily recognize that the heat pump includes a compressor and an expander (see, for example, the Dictionary of Mechanical Engineering (1996 G.H.F. Nayler Fourth Edition). As clearly seen in Fig. 1 of Yamanishi, the refrigerator 5 includes a regenerator 5a, a condenser 5b, an evaporator 5c and an absorber 5d. Somewhat confusingly, Yamanishi describes the refrigerator 5 that "is operated as a heat pump", but not actually being a heat pump.

In fact, Yamanishi, cited and described in the present application, proposes an exhaust heat recovery system in which cooling water for a steam turbine condenser is used. More specifically, cooling water passes through the evaporator 5c to make warm water for heating

purposes.

Moreover, it should be noted that Yamanishi discloses a heat source water circulation line 8 provided between a condenser 4 and a evaporator 5c of a refrigerator 5. It is therefore to be understood that the refrigerator 5 of Yamanishi is neither "connected with a cooling medium side channel of the condenser" nor "directly" recovers the heat from the steam turbine facility as recited in claim 1 of the instant application.

The heat recovery system of Yamanishi, also, has disadvantages. As described in detail in the present application, in the heat recovery system of Yamanishi the absorption chiller is employed to generate warm water. However, the absorption chiller requires another working medium, that is, an absorbent solution, in addition to the refrigerant. Further required, in addition to the evaporator, are an absorber, a regenerator, and if more improved thermal efficiency is desired, a high-temperature regenerator. The multitude of these elements leads to undesired upsizing of the system. Moreover, the absorber of the absorption chiller which has to permit a heat exchange, material exchange and phase change to simultaneously take place inside between the absorbent solution and the refrigerant/cooling water; thus, the complexity in the construction of the absorber and the resulting limitation placed on miniaturization thereof would pose a problem. Furthermore, the exhaust heat recovery system of Yamanishi is provided with a cooling water channel, through which water or the like flows, interposed between the condenser and the evaporator of the absorption chiller. Thus, the heat exchange efficiency in the condenser is kept low, and the size of the condenser cannot be made compact any more, which are also

perceived as disadvantages thereof.

In any event, the Examiner concedes that Yamanishi does not disclose the compression type heat pump.

The Examiner further alleges that Wilkinson teaches the use of the compression heat pump in a waste heat recovery system of a steam turbine plant.

Contrary to the Examiner's allegations, the system of Wilkinson is related to the use of an "absorption heat pump system having one or more stages which efficiently sensible waste heat from industrial or other sources to boost a portion of that heat to a useful level" (see column 1, lines11-15). Although Wilkinson also teaches that a heat pump can be used to increase the temperature of waste heat (available as low pressure steam or heated fluid) to a useable level, nowhere in the specification Wilkinson mentions a waste heat of a <u>steam turbine plant</u>. The Applicant kindly requests the Examiner to point to a specific place (column, line) in the '515 patent where Wilkinson discloses the recited waste heat from the steam turbine plant.

Moreover, contrary to the Examiner's allegations, the system of Wilkinson, although mentions a vapor compression heat pump, teaches that "it has been suggested to utilize some of the waste heat available in a heat engine to <u>drive the compressor</u> in a vapor compression heat pump cycle" (see column 1, lines 57-59). Again, the compressor of the compression type heat pump recited in claim 1 is not driven by the waste heat from the steam turbine plant.

Thus, Wilkinson fails to disclose the use of the compression heat pump in a waste heat recovery system of a steam turbine plant, wherein a heat channel of a compression type heat

pump is connected with a cooling medium side channel of the condenser in order to directly recover the heat from the steam turbine facility.

In chemical and food processing industries, the condensing or drying process is carried out, which evaporates a solvent (water in most instances) from a solution. Heat applied to evaporate the solvent is dissipated in the form of steam or vapor, and is released by a condenser into cooling water or the air. The steam, in general, has a temperature of several tens to 100°C at atmospheric pressure. On the other hand, a steam turbine power plant generates a high-temperature and high-pressure steam in a boiler, which is utilized to rotate a turbine for driving a generator, and then becomes a low-temperature and low-pressure steam of 33°C or so at approximately 0.05 atmospheric pressure. The low-temperature and low-pressure steam is cooled in a condenser and waste heat is released into the air or cooling water. Hereupon, assuming that the low-temperature and low-pressure steam coming from the turbine of the steam turbine power plant were condensed again (i. e., the vapor were restored, using a power, to a state before the vapor doing work in the turbine), the work done would become canceled in its entirety at best, and would cause a loss in energy to the extent that the efficiencies of the turbine, condenser and generator are less than 100%. Heat recovery in this way would, needless to say, be silly, and it would be much better than that to directly utilize heat of the steam of 33°C or so. The steam of 33°C has a density of 0.357kg/m3, which is great in specific volume, thus requiring a large-sized compressor.

After reviewing existing heat pumps, Wilkinson concluded that an absorption heat pump is by far superior to a compression type heat pump. Wilkinson clearly discloses that "In order to eliminate the need for a compressor and turbine, an absorption cycle heat pump process may be utilized." Thus, Wilkinson teaches directly away from the present invention as recited in claim 1.

Therefore, as both Yamanishi and Wilkinson teach the absorption type heat pump, even if combination and modification of Yamanishi and Wilkinson, suggested by the Examiner, could be made, the resulting device still would lack the compression type heat pump having a heat channel connected with the cooling medium side channel of the condenser of the steam turbine facility.

Moreover, Yamanishi and Wilkinson cited by the Examiner provide no suggestion or motivation to modify the teachings of the prior art to provide a heat recovery system having with a compression type heat pump as recited in claim 1 of the present application. As a result, one of ordinary skill in the art would not find obvious to modify the teachings of the prior art to provide the heat recovery system having with a compression type heat pump as recited in claim 1 of the present application.

Hence, a rejection of claim 1 under 35 USC § 103(a) is improper.

Claims 2-4 depend upon claim 1 and further define the present invention over the prior art.

<u>Further regarding claim 2</u>: in addition to the arguments presented above regarding the patentability of claim 1, the prior art fails to disclose carbon dioxide used as s refrigerant in a

compression type heat pump.

According to one embodiment of the present invention, steam of 33°C or so at approximately 0.05 atmospheric pressure is subjected to heat exchange with liquid carbon dioxide (as set forth in claim 2) of 20 °C at 5.7MPa to obtain gaseous carbon dioxide of 25°C at 5.7MPa, which is led directly into a compressor of the heat pump to obtain carbon dioxide of 90°C at 12MPa, which is in turn subjected to heat exchange with water of 25°C to obtain warm water at approximately 83°C. When carbon dioxide of approximately 31°C at 12MPa which is obtained by the above heat exchange is expanded to 5.7MPa, liquid carbon dioxide of 20°C at 5.7MPa is obtained again, which is used for cooling the condenser. In this setup, the gaseous carbon dioxide of 25°C at 5.7MPa has a density of 2505kg/m3, which is approximately 700 times greater than the density of steam of 33OC. In other words, transfer of heat from steam to carbon dioxide is accompanied by compression of the steam, and allows the compressor to become compact in size and save energy for compression. As a result, a high coefficient of performance (COP=4.9) is achieved which shows that thermal energy five times greater than the input energy is obtained.

Cost effectiveness of utilization of heat achieved by exhaust heat recovery may be evaluated by payout period (years) CRT as indicated by the following equation:

$$CRT = (CIC-GIC) / (GRC-CRC)$$

where CIC denotes an initial cost for the exhaust recovery system, GIC - an initial cost for a gas boiler, GRC - an annual operating cost for the gas boiler, and CRC an annual operating cost for

the exhaust recover system. It is said that five years or shorter payout period derived from the above equation for evaluation will give good reason for a business (or non-profit) entity to invest in the heat recovery system.

As a result of evaluation of our heat recovery system using the above equation, the payout period of the system turned out to be 3.7 years; therefore, OUT system is evaluated cost effective in utilization of heat.

Hence, a rejection of claim 2 under 35 USC § 103(a) is improper.

Therefore, it is respectfully submitted that claims 1-4 define the invention over the prior art of record and are in condition for allowance, and notice to that effect is earnestly solicited. Should the Examiner believe further discussion regarding the above claim language would expedite prosecution they are invited to contact the undersigned at the number listed below.

Respectfully submitted:
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